GLOBAL WEATHER PREDICTION AND HIGH-END COMPUTING AT NASA

The authors demonstrate the current capabilities of NASA's finite-volume General Circulation Model in high-resolution global weather prediction and discuss its development path in the foreseeable future. This model is a prototype of a future NASA Earth-modeling system intended to unify development activities across various disciplines within NASA's Earth Science Enterprise.

NASA's goal for an Earth-modeling system is to unify the model development activities that cut across various disciplines in the Earth Science Enterprise, which is a NASA organization for all NASA's activities related to Earth science. Earth-modeling system applications include, but are not limited to, weather and chemistry climate-change predictions and atmospheric and oceanic data assimilation. High-resolution global weather prediction, among these applications, requires the highest temporal and spatial resolution, and, hence, demands the most capability from a high-end computing system.

In the continuing quest to improve and perhaps push the limit of weather prediction (see the "Weather Predictability" sidebar), we are adopting more physically-based algorithms with much higher resolution than that of earlier models, which is crucial to improving forecast skill. We also are including additional physical and chemical components such as a chemical transport model previously not coupled to modeling systems.

Because a comprehensive high-resolution Earth-modeling system requires enormous computing power, we must design all component models efficiently for parallel computers with distributed-memory platforms. To this end, we started developing the finite-volume General Circulation Model (fvGCM) of the atmosphere, which is based on the work of Shian-Jiann Lin and Richard Rood[1–4] and their collaboration with the National Center for Atmospheric Research (NCAR). Some of the fvGCM's more technical aspects and climate characteristics appear elsewhere.[5]

In this article, we will first demonstrate the model's current capabilities in high-resolution global weather forecasting by predicting real weather events in terms of both accuracy and efficiency, and then outline the model's development-evolution path and its computer requirements in the foreseeable future.

The Current High-End Modeling System for Weather Prediction

The fvGCM features a unique finite-volume dynamics system with local conservation and monotonicity to ensure a global consistency of simulated or predicted atmospheric dynamical processes. It describes the Earth's surface with the traditional latitude–longitude grid system consisting of a set of grid boxes defined along the latitude circles and along the meridians. We assume that the model atmosphere is in hydrostatic equilibrium—that is, the

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